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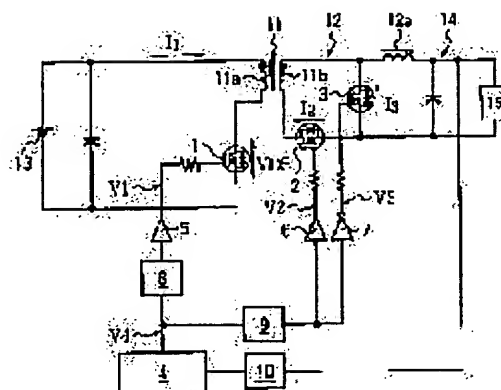
TAKAGI MASAKAZU

(54) SWITCHING POWER SUPPLY

(57)Abstract:

PROBLEM TO BE SOLVED: To control generation of loss and noise due to difference of the operation delay time of a switching element by providing a signal timing adjusting means so that the timing of input of the control signal to the first switching means is delayed from input of the control signal to the second and third switching means.

SOLUTION: A delay circuit 8 is arranged to the circuit between the control circuit 4 and drive circuit 5 of first switching element 1. An insulation circuit 9 connected to the drive circuits 6, 7 of the second and third switching elements 2, 3 is connected to the control circuit 4 between the control circuit 4 and delay circuit 8. The control signal V4 from the control circuit 4 is input in direct to the drive circuits 6, 7 but input to the drive circuit 5 via a delay circuit 8. When a current I3 becomes zero, the third switching element 3 turns Off to impede a terminating current of the secondary coil 11b of transformer 11. Until the time when the current I2 starts to flow, the second switching element 2 is in the ON state. Therefore, the current I2 does flow into a parasitic diode and flows only through the channel between the drain and source of the element 2.



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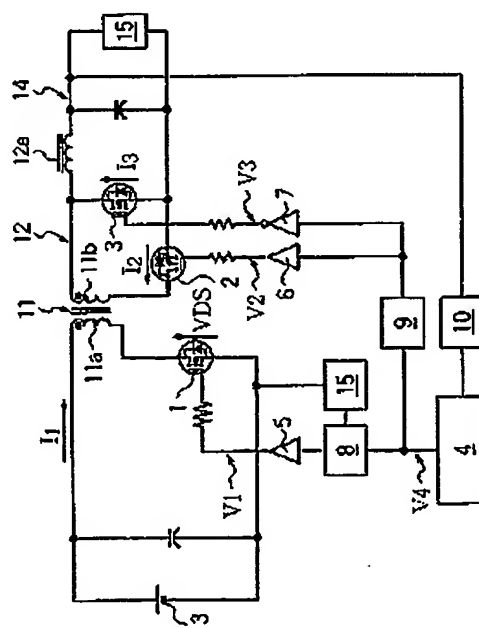
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(54) 【発明の名称】 スイッチング電源装置

(57) 【要約】

【課題】 同期整流型スイッチング電源装置において、スイッチ回路のスイッチング素子と整流回路のスイッチング素子の作動遅れ時間の相違による損失及びノイズの発生を抑制できるスイッチング電源装置を提供すること。電源装置は、一次側のスイッチ手段と整流回路のスイッチ手段の間の耐圧特性の差に基づく作動遅れ時間の差を補償するため、該整流回路のスイッチ手段に制御信号が入力されるタイミングよりも一次側のスイッチ手段に制御信号が入力されるタイミングが遅くなるようにする信号タイミング調整手段を有する。この信号タイミング調整手段は、一次側スイッチ手段に入力される制御信号のタイミングを遅らす遅延手段として構成する。



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【特許請求の範囲】

【請求項1】 入力電圧を高周波電圧に変換する第1のスイッチ手段を有するスイッチ回路と、

前記スイッチ回路に1次巻線が接続され、2次巻線が出力回路に接続された変圧器と、を備え、前記出力回路は、前記変圧器の前記2次巻線に直列に接続された第2のスイッチ手段及び磁気素子と、前記2次巻線に並列に接続された第3スイッチ手段とからなる整流手段を有し、

出力電圧が所定の値となるように前記第1のスイッチ手段をオン・オフ制御するため前記第1のスイッチ手段に与えられる制御信号を形成する制御手段が設けられ、前記第2のスイッチ手段は前記第1のスイッチ手段に与えられる制御信号と同期した前記制御手段からの信号でオン・オフ制御され、前記第3のスイッチ手段は前記第1のスイッチ手段に与えられる制御信号とは逆のタイミングを有する前記制御手段からの信号でオン・オフ制御されるようになった、同期整流型電源装置であって、

前記第1のスイッチ手段と前記第2及び前記第3のスイッチ手段の間の耐圧特性又は電流容量の差に基づく作動遅れ時間の差を補償するため前記第2及び第3のスイッチ手段に制御信号が入力されるタイミングよりも前記第1のスイッチ手段に制御信号が入力されるタイミングが遅くなるようにする信号タイミング調整手段が設けられた、ことを特徴とする同期整流型スイッチング電源装置。

【請求項2】 請求項1に記載したスイッチング電源装置であって、前記信号タイミング調整手段は、前記第1のスイッチ手段に入力される制御信号のタイミングを遅らす遅延手段であることを特徴とするスイッチング電源装置。

【請求項3】 請求項2に記載したスイッチング電源装置であって、前記遅延手段は、前記第1スイッチ手段へのオン信号に対する遅延時間とオフ信号に対する遅延時間とを別々に設定できるようになったことを特徴とするスイッチング電源装置。

【請求項4】 請求項3に記載したスイッチング電源装置であって、負荷電圧検出手段が設けられ、前記第1スイッチ手段へのオン信号に対する遅延時間が負荷電流の大きさに応じて変化させられるようになったことを特徴とするスイッチング電源装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は、入力電圧をスイッチ手段によりスイッチングして高周波電圧に変換し、この高周波電圧を変圧器により変圧し、整流して任意の出力電圧を出力するスイッチング電源装置に関する。特に本発明は、出力部の整流回路の整流素子としてスイッチ手段を設け、該スイッチ手段を入力回路のスイッチ手段の

作動と同期して作動させるようにした同期整流型スイッチング電源装置に関する。

【0002】

【従来技術】 入力電圧をスイッチ手段により高周波電圧に変換して変圧器の1次巻線に印加し、この変圧器の2次巻線を整流回路を有する出力回路から直流出力として取り出すようにしたスイッチング電源装置はよく知られている。このスイッチング電源装置においては、整流回路は、変圧器の2次巻線に直列に接続されたダイオード等の整流素子とコイル等の磁気素子、及び、2次巻線に並列に接続され別の整流素子を備える。入力側のスイッチ手段は、出力電圧が所定の値となるように制御回路からの制御信号によりオン・オフ制御される。この形式のスイッチング電源装置において、ダイオードに固有の順方向降下電圧による損失を軽減するためにダイオードに代えてスイッチ素子を使用し、これらのスイッチ素子を入力側のスイッチ手段と同期させてオン・オフ制御するようにした構成が、同期整流型スイッチング電源装置として知られており、これらの形式のスイッチング電源装置の代表的なものは、特開平4-4750号公報、特開平5-260738号公報及び特開平7-194104号公報、並びに米国特許第4,870,555号明細書に記載されている。

【0003】 図5に、従来の同期整流型スイッチング電源装置の一例を示す。図5において、電源13は変圧器11の一次巻線11aに接続され、該一次巻線11aにはさらにFET型のスイッチ素子1が接続される。変圧器11の二次側巻線11bには、整流回路12を有する出力回路14が接続され、該出力回路14は負荷15に接続される。整流回路12は、変圧器11の二次巻線11bに直列に接続された第2のスイッチ素子2と磁気素子すなわちインダクタ12aを備える。また、整流回路12は、変圧器11の二次巻線11bに並列に接続された第3のスイッチ素子3を備える。スイッチ素子1、2、3を制御するために制御回路4が設けられている。制御回路4は、フォトカプラ又は変圧器などで構成される絶縁回路9或いは負荷電圧検出回路10を介して出力回路14に接続されており、出力電圧が一定になるようにパルス幅を調整した、スイッチ素子1を制御するための制御信号V4を出力する。制御回路4の出力V4は、駆動回路5を介して出力V1として第1のスイッチ素子1のゲート電極に印加される。制御回路4からの制御信号V4は又、変圧器又はフォトカプラなどで構成された絶縁回路9を介して駆動回路6、7に接続される。駆動回路6は、第1のスイッチ素子1に印加される出力V1と同じ極性の出力V2を第2のスイッチ素子2のゲート電極に印加する。駆動回路7は、第1のスイッチ素子1に印加される出力V1とは逆極性の出力V3を第3のスイッチ素子3のゲート電極に印加する。

【0004】 周知のように、制御回路4からの制御信号により第1のスイッチ素子1がオン・オフ制御されて電

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源13からの電圧を高周波電圧とし、この高周波電圧が変圧器11の一次巻線に印加される。変圧器11の二次巻線11bに発生する電圧は整流回路12により整流されて出力回路14から出力される。出力回路14の出力電圧は負荷電圧検出回路10により検出されて制御回路4に入力される。制御回路4は、出力電圧が所定の値となるように第1のスイッチ素子1を制御するための制御信号を生成する。整流回路12において、第1のスイッチ素子1がオン状態のときは第2のスイッチ素子2もオン状態となり、第3のスイッチ素子3はオフ状態になる。第1のスイッチ素子1がオフになると、第2のスイッチ素子2もオフになり、第3のスイッチ素子3はオンになる。

【0005】ここで、第1、第2、第3のスイッチ素子1、2、3に同じタイミングで制御信号が印加される場合には、スイッチ素子を構成するFETの作動特性のために、各スイッチ素子間で動作のタイミングにずれを生じる。すなわち、スイッチ素子のゲート電極に駆動電圧が印加されてから該スイッチ素子を流れるドレイン電流が定常値に達するまでの動作遅れ時間及びゲート電極に印加される電圧が絶たれてからドレイン電流が流れなくなるまでの動作遅れ時間がある。この遅れ時間のために、スイッチング電源装置の効率が低下する。この点を詳細に説明すると、入力側は電圧が高いために、入力側のスイッチ素子1を構成するFETは、一般に耐圧が比較的高く、電流容量の小さいものが使用される。したがって、このスイッチ素子1は、ゲート電極に駆動電圧が印加されてからオン状態となるまでの遅れ時間及び駆動電圧が除去されてからオフ状態となるまでの遅れ時間が比較的小さい。これに対して、出力側は電圧が低く、出力側のスイッチ素子2、3を構成するFETは、一般に耐圧が低く電流容量の大きいものが使用される。このため、これらスイッチ素子2、3においては、ゲート電極に駆動電圧が印加されてからオン状態となるまでの遅れ時間及び駆動電圧が除去されてからオフ状態となるまでの遅れ時間が比較的小さい。

【0006】図5に示すスイッチング電源装置の各部の電圧又は電流波形を図6に示す。時刻 t_0 で制御信号V4がローからハイになると、駆動回路5からの出力V1と駆動回路6からの出力V2が同時にハイになる。また、駆動回路7からの出力V3は同じタイミングでローになる。この時刻 t_0 からスイッチング素子の作動特性に応じた遅れ時間の後、時刻 t_1 でスイッチング素子1がオンになり、電流 I_1 が変圧器11の一次側巻線11aに流れる。同時に、変圧器11の二次側巻線11bに電流 I_2 が発生する。スイッチング素子1のオフ状態でスイッチング素子3に流れていた電流 I_3 は、時刻 t_1 で減少し始め、時刻 t_2 でゼロになる。素子の特性上、スイッチング素子3の作動遅れ時間はスイッチング素子1の遅れ時間より長いので、この時点ではスイッチング

素子3はまだオン状態にある。したがって、変圧器11の二次巻線11bは、スイッチング素子2、3を介して短絡状態となり、大きな短絡電流が流れ、効率低下及びノイズの原因となる。また、スイッチング素子2も作動遅れ時間がスイッチング素子1よりも長いので、この時点では、スイッチング素子2はオフ状態にある。そのため、該スイッチング素子2を通して流れる短絡電流は、ドレイン・ソース間のチャンネルではなく、内部の寄生ダイオードを流ることになるので、損失が大きくなる。図6において、電流 I_1 、 I_2 のうち寄生ダイオードに流れる電流を斜線で示す。

【0007】時刻 t_1 で制御信号V4がハイからローになると、駆動回路5からの出力V1と駆動回路6からの出力V2がローになる。駆動回路の出力V3は同じタイミングでローからハイになる。時刻 t_1 からスイッチング素子の作動特性に応じた遅れ時間の後、時刻 t_2 でスイッチング素子1がオフになり、電流 I_1 、 I_2 が減少し始め、電流 I_3 が増加し始める。このとき、スイッチング素子3はまだオン状態でないため、該スイッチング素子3には寄生ダイオードを通して電流が流れるようになり、損失が大きくなる。図6に、電流 I_1 、 I_2 のうち、寄生ダイオードに流れる電流を斜線で示す。

【0008】

【発明が解決しようとする課題】 本発明は、上述した形式の同期整流型スイッチング電源装置において、スイッチ回路のスイッチング素子と整流回路のスイッチング素子の作動遅れ時間の相違による損失及びノイズの発生を抑制できるスイッチング電源装置を提供することを解決すべき課題とする。

【0009】

【課題を解決するための手段】 上記課題を解決するための本発明によるスイッチング電源装置は、入力電圧を高周波電圧に変換する第1のスイッチ手段を有するスイッチ回路と、該スイッチ回路に1次巻線が接続され、2次巻線が出力回路に接続された変圧器と、を備え、該出力回路は、変圧器の2次巻線に直列に接続された第2のスイッチ手段及び逆気素子と、2次巻線に並列に接続された第3のスイッチ手段とからなる整流手段を有し、出力電圧が所定の値となるように第1のスイッチ手段をオン・オフ制御するため該第1のスイッチ手段に与えられる制御信号を形成する制御手段が設けられ、第2のスイッチ手段は第1のスイッチ手段に与えられる制御信号と同期した制御手段からの信号でオン・オフ制御され、第3のスイッチ手段は第1のスイッチ手段に与えられる制御信号とは逆のタイミングを有する制御手段からの信号でオン・オフ制御されるようになった。同期整流型の装置である。本発明の電源装置は、その特徴として、第1のスイッチ手段と第2及び第3のスイッチ手段の間の耐圧特性又は電流容量の差に基づく作動遅れ時間の差を補償するため第2及び第3のスイッチ手段に制御信号が入

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力されるタイミングよりも第1のスイッチ手段に制御信号が入力されるタイミングが遅くなるようにする信号タイミング調整手段を有する。この信号タイミング調整手段は、第1のスイッチ手段に入力される制御信号のタイミングを遅らす遅延手段として構成することが最も望ましい。この場合、該遅延手段は、第1スイッチ手段へのオン信号に対する遅延時間とオフ信号に対する遅延時間とを別々に設定できるようにすることが好ましい。本発明のさらに好ましい態様においては、負荷電流検出手段

【0010】本発明のスイッチング電源装置においては、上述のように、信号タイミング調整手段により、第1のスイッチ手段と第2及び第3のスイッチ手段の間の耐圧特性の差に基づく作動遅れ時間の差を補償するため第2及び第3のスイッチ手段に制御信号が入力されるタイミングよりも第1のスイッチ手段に制御信号が入力されるタイミングが遅くなるように調整するので、第1、第2、第3スイッチング素子のオン・オフタイミングを完全に同期させることができ、スイッチング素子の寄生ダイオードに流れる電流を減少させて損失を低下させ、ノイズの発生を抑制することができる。

【0011】

【実施例】以下、本発明の実施例を図について説明する。先ず図1を参照すると、ここに示された実施例の回路は、図5に示す従来の回路と、構成及び作用ともほぼ同一で、対応する部分は同一の符号を付して詳細な説明を省略する。この実施例の回路では、制御回路4から第1のスイッチング素子1の駆動回路5に至る回路に遅延回路8が配置される。第2、第3のスイッチング素子2、3の駆動回路6、7に接続される絶縁回路9は、制御回路4と遅延回路8の間で制御回路4に接続される。したがって、制御回路4からの制御信号V4は、駆動回路6、7には直接入力されるが、駆動回路5には遅延回路8を経て入力される。図2に、図1に示す回路の各部の電圧又は電流波形を示す。時刻t₁で制御信号V4がローからハイになると、駆動回路6からの出力V2がハイになり、同時に、駆動回路7からの出力V3は同じタイミングでローになる。第1のスイッチング素子1の駆動回路5には、制御信号V4が時間ΔT₁だけ遅れて入力されるので、駆動回路5の出力V1は、時刻t₁より時間ΔT₁だけ遅れた時刻t₂でローからハイになる。スイッチング素子1は時刻t₂から該スイッチング素子の動作特性に応じた遅れ時間の後、時刻t₃でオンになり、電流I₁が変圧器11の一次巻線11aに流れ、同時に、変圧器11の二次巻線11bに電流I₂が発生する。スイッチング素子1のオフ状態でスイッチング素子3に流れていた電流I₃は時刻t₄で減少し始め、時刻t₅でゼロになる。時刻t₆では電流I₁、I₂も定常

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値に達する。スイッチング素子3は時刻t₇から該スイッチング素子の動作特性に応じた遅れ時間の後、時刻t₈でオフする。ΔT₂は時刻t₇でスイッチ素子3がオフするように定められている。一般にスイッチング素子における作動遅れ時間は、オフする時の方がオンする時間が長いので、スイッチング素子2は時刻t₉よりも早い時点でオンになっている。

【0012】この回路においては、時刻t₁で電流I₁、I₂がゼロになると、第3のスイッチング素子3もオフになるので、変圧器11の二次巻線11bに短絡電流が流れるのを阻止できる。電流I₂が流れ始める時刻t₁までに第2のスイッチング素子2はオン状態になっているので、電流I₂は素子2のドレイン・ソース間のチャンネルを流れ、寄生ダイオードには電流はほとんど流れない。このようにして、本発明のこの実施例では、損失を低減し、ノイズを減少させることができる。時刻t₁で制御信号V4がハイからローになると、駆動回路6の出力V2がローになる。駆動回路の出力V3も同じタイミングでローからハイになる。第1のスイッチング素子1の駆動回路5の出力V1は、時刻t₁から時間ΔT₁だけ遅れた時刻t₂でハイからローになる。この時刻t₂からスイッチング素子の動作特性に応じた遅れ時間の後、時刻t₃でスイッチング素子1がオフになり、電流I₁、I₂が減少し始め、電流I₃が増加し始める。時間ΔT₂は、第1のスイッチング素子1がオン状態からオフ状態になる場合の作動遅れ時間と第3のスイッチング素子3がオフ状態からオン状態になる場合の作動遅れ時間の差に対応するように定めてあるので、時刻t₄でスイッチング素子1がオフになるときに、スイッチング素子3はすでにオン状態になっており、該スイッチング素子3には寄生ダイオードを通して電流はほとんど流れない。

【0013】一般に、スイッチング素子における作動遅れ時間は、オフする時の方がオンする時より長い。したがって、この実施例では、第2のスイッチング素子2がオフするタイミングは、時刻t₇より遅れた時刻t₈となる。したがって、電流I₂は時刻t₇までスイッチング素子2のチャンネルを流れることができ、寄生ダイオードに流れることはない。上述の実施例において、制御信号V4がローからハイになる場合の遅延回路の遅れ時間ΔT₁と、制御信号V4がハイからローになる場合の遅延回路の遅れ時間ΔT₂は、それぞれ別個に選定することが望ましいが、同じ値にしても相当程度の効果を達成することができる。なお、回路の構成、入力状態或いはスイッチング素子の特性によっては、制御信号V4がハイからローになる場合の遅延回路の遅れ時間ΔT₁はゼロとしてもよい。

【0014】図3に本発明の他の実施例を示す。この実施例では、制御回路4は変圧器11の二次側回路内に配置されており、該制御回路4からの制御信号V4は、絶

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録回路を経ずに直接に駆動回路6、7に入力される。その他の点では、この実施例は図1の実施例と同様であり、作動も同じである。図4は、本発明のさらに別の実施例を示す。この実施例では、変圧器11の一次側回路に電流検出回路15が設けられる。この電流検出回路15は遅延回路8に接続され、出力電流の減少に応じて遅れ時間 ΔT 、が大きくなり、出力電流の増加に応じて遅れ時間 ΔT 、が小さくなるように遅延回路8を制御する。図1の実施例の構成では、負荷電流が減少すると、電流I₁、が定常値からゼロになる時刻及び電流I₁、
10、I₂、がゼロから定常値になる時刻は、t₁、より早くなり、時刻t₁、に近づく。ところが、第3のスイッチング素子3がオフする時刻は、t₁、のままであるので、スイッチング素子3がオン状態を継続している間にスイッチング素子1、2がオン状態になる。このため、変圧器11の二次側巻線を通る回路には、スイッチング素子2、3を介して短絡電流が流れ、ノイズ発生の原因となる。図4の実施例は、出力電流に応じて遅れ時間を制御するので、この問題を解消することができる。

【0015】本発明の構成により達成できる効率改善を特定の例について試算した。仮定として、従来の回路においては、スイッチング素子の動作遅れの違いにより、スイッチング素子の寄生ダイオードに211 nSの間電流が流れ、寄生ダイオードにおける電圧降下は0.9 Vとする。電源装置の仕様は、V_o = 3.3 V、I_o = 15 A、駆動周波数を250 kHzとし、スイッチング素子の導通状態での抵抗値を5.7 mΩとする。ダイオードで整流回路を構成した場合の効率は75%とすると、このダイオードをFET型のスイッチング素子に置き換えた整流回路を備える同期整流型スイッチング電源装置の効率は、82.9%となり、図1に示す本発明の実施例の装置の効率は83.9%になる。この計算においては、本発明により得られる効果のうち、スイッチング素子の動作遅れを補償することにより得られる効率の改善のみを考慮したものである。本発明においては、この他に、短絡電流に起因する損失の改善効果が達成され、ノイズ軽減効果も顕著である。

【0016】図7に、上述の計算に用いた仕様の回路における動作遅れ時間 ΔT 、をゼロとし、 ΔT 、を変化させた場合の効率の変化と、短絡電流及びリカバリ電流の変化を示す。ここで、短絡電流及びリカバリ電流は、第
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3のスイッチング素子3を流れる電流I₁、のうち、矢印と反対方向に流れる電流を指す。この図から、遅延時間を増加させると、短絡電流が減少し、効率が約5%改善されることが分かる。この効率改善には、第2のスイッチング素子2の動作遅れの補償が寄与する部分もある。遅延時間が大きくなり過ぎると、電流I₁、が流れているときに第3のスイッチング素子3がオフする状態を生じるので、電流I₁、が寄生ダイオードを流れることになり、効率が低下する。寄生ダイオードに電流I₁、が流れている途中で第1のスイッチング素子1がオンになると、第3のスイッチング素子3の寄生ダイオードにリカバリ電流が流れる。このリカバリ電流は遅延時間に比例して増加し、効率を悪くする原因になる。

【0017】なお、図4の実施例において、負荷電流の検出に、変圧器11の一次側回路に接続した電流検出回路15を用いたが、この電流検出回路15は、変圧器11の二次側回路に設けてもよい。

【図面の簡単な説明】

【図1】 本発明の一実施例によるスイッチング電源装置を示す回路図である。

【図2】 図1の回路における各部の電圧又は電流の波形を示す波形図である。

【図3】 本発明の他の実施例によるスイッチング電源装置を示す図1と同様な回路図である。

【図4】 本発明のさらに他の実施例によるスイッチング電源装置を示す図1と同様な回路図である。

【図5】 従来の同期整流型スイッチング電源装置の一例を示す図1と同様な回路図である。

【図6】 図5の回路における各部の波形を示す図である。

【図7】 本発明に実施例における遅延時間により得られる効率の改善と短絡電流及びリカバリ電流の変化を示す図表である。

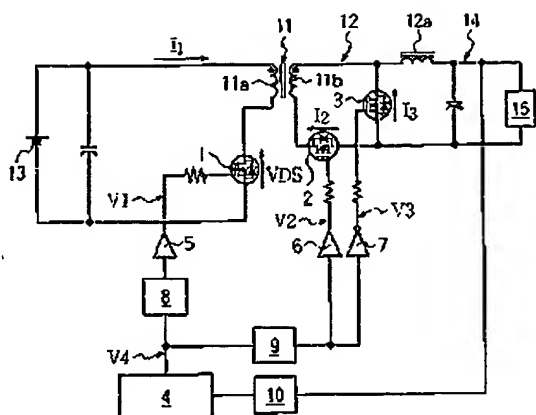
【符号の説明】

1、2、3・・・スイッチング素子、4・・・制御回路、5、6、7・・・駆動回路、8・・・遅延回路、9・・・絶縁回路、10・・・負荷電圧検出回路、11・・・変圧器、12・・・整流回路、13・・・電源、14・・・出力回路、15・・・負荷

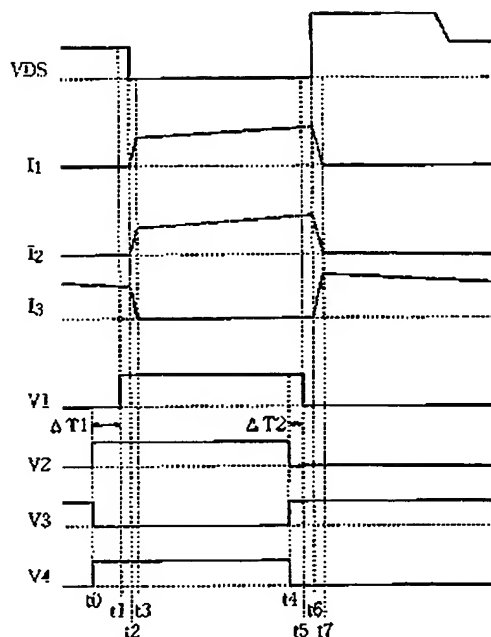
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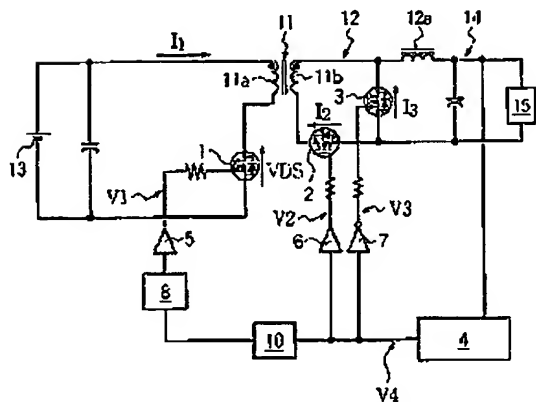
【図1】



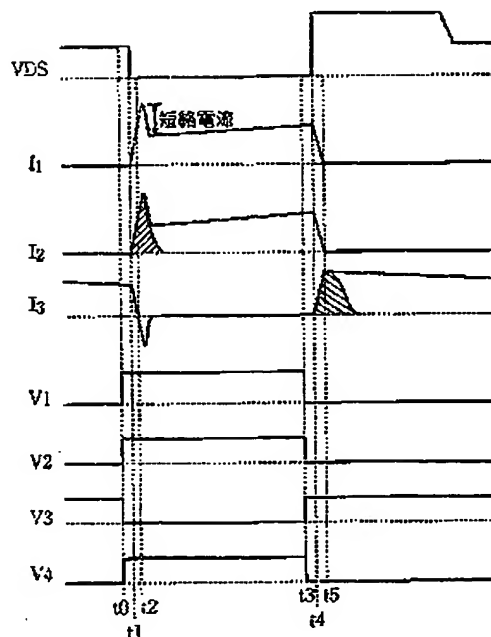
【図2】



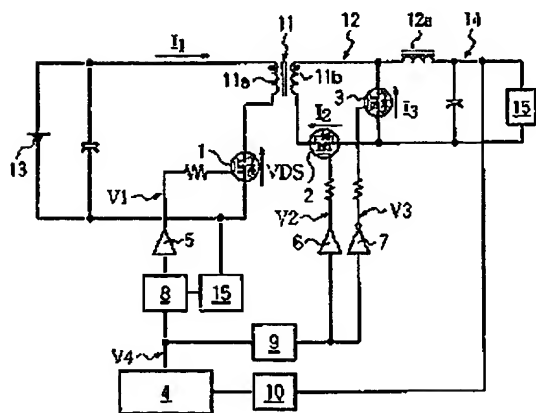
【図3】



【図6】



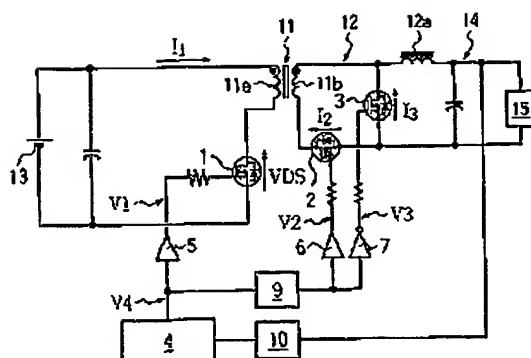
【図4】



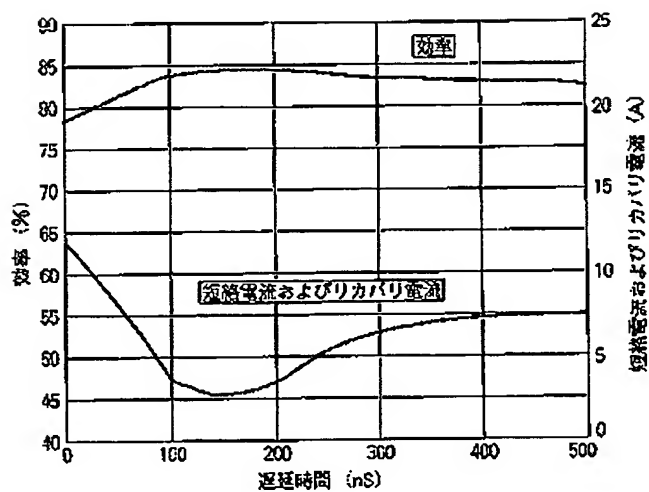
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【図5】



【図7】



特開平 1 1 -

【公報種別】特許法第 17 条の 2 の規定による補正の掲載

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【手続補正 1】

【補正対象書類名】明細書

【補正対象項目名】特許請求の範囲

【補正方法】変更

【補正内容】

【特許請求の範囲】

【請求項 1】 入力電圧を高周波電圧に変換する第 1 のスイッチ手段を有するスイッチ回路と、
前記スイッチ回路に 1 次巻線が接続され、2 次巻線が出力回路に接続された変圧器と、
を備え、前記出力回路は、前記変圧器の前記 2 次巻線に直列に接続された第 2 のスイッチ手段及び磁気素子と、
前記 2 次巻線に並列に接続された第 3 スwitch 手段とからなる整流手段を有し、
出力電圧が所定の値となるように前記第 1 のスイッチ手段をオン・オフ制御するため前記第 1 のスイッチ手段に与えられる制御信号を形成する制御手段が設けられ、
前記第 2 のスイッチ手段は前記第 1 のスイッチ手段に与えられる制御信号と同期した前記制御手段からの信号でオン・オフ制御され、

同期整流型電源装置であって、

前記第 1 のスイッチ手段と前記第 2 及び第 3 スwitch 手段の間の耐圧特性又は電流容量の遅れ時間の差を補償するため前記第 2 及び第 3 スwitch 手段に制御信号が入力されるタイミング
第 1 のスイッチ手段に制御信号が入力されるようになるようにする信号タイミング調整した、ことを特徴とする同期整流型スイッチ装置。

【請求項 2】 請求項 1 に記載したスイッチ装置であって、前記信号タイミング調整手段のスイッチ手段に入力される制御信号の遅延手段であることを特徴とするスイッチ装置。

【請求項 3】 請求項 2 に記載したスイッチ装置であって、前記遅延手段は、前記第 1 のオン信号に対する遅延時間とオフ信号間とを別々に設定できるようになったスイッチング電源装置。

【請求項 4】 請求項 3 に記載したスイッチ装置であって、負荷電流検出手段が設けられ、スイッチ手段へのオン信号に対する遅延時間

Japanese Patent Application Publication No. 11-235029

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1. This document has been translated by computer. So the translation may not reflect the original precisely.

2. **** shows the word which can not be translated.

3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] A switching circuit which has the 1st switching means which changes input voltage into high-frequency voltage, It has ***** by which a primary coil was connected to said switching circuit, and a secondary coil was connected to an output circuit. Said output circuit The 2nd switching means and magnetic cell which were connected to said secondary coil of said transformer at a serial, It has a rectification means which becomes said secondary coil from the 3rd switching means connected to juxtaposition. A control means which forms a control signal given to said 1st switching means in order to carry out on-off control of said 1st switching means so that output voltage may serve as a predetermined value is established. On-off control of said 2nd switching means is carried out by signal from said control means which synchronized with a control signal given to said 1st switching means. On-off control of said 3rd switching means came to be carried out to a control signal given to said 1st switching means by signal from said control means which has timing of reverse. It is a synchronous detection mold power unit. In order to compensate a difference of an actuation time delay based on said 1st switching means, said 2nd [the] and a resisting pressure property between said 3rd switching means, or a difference of current capacity Synchronous detection mold switching telegraph-key equipment characterized by what a signal timing adjustment means to make it timing as which a control signal is inputted into said 1st switching means rather than timing as which a control signal is inputted into said 2nd and 3rd switching means become late was established for.

[Claim 2] It is switching power supply equipment characterized by being a delay means to delay the timing of a control signal of being switching power supply equipment indicated to claim 1, and inputting said signal timing adjustment means into said 1st switching means.

[Claim 3] It is switching power supply equipment characterized by the ability to set up now independently a time delay [as opposed to / are switching power supply equipment indicated to claim 2, and / an ON signal to said 1st switching means in said delay means], and a time delay over an off signal.

[Claim 4] Switching power supply equipment characterized by being switching power supply equipment indicated to claim 3, establishing a load current detection means, and coming to

change a time delay over an ON signal to said 1st switching means according to magnitude of the load current.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention switches input voltage by the switching means, changes it into high-frequency voltage, and relates to the switching power supply equipment which transforms this high-frequency voltage with a transformer, rectifies and outputs the output voltage of arbitration. Especially this invention establishes a switching means as a rectifying device of the rectifier circuit of the output section, and relates to the synchronous detection mold switching power supply equipment it was made to operate this switching means synchronizing with actuation of the switching means of an input circuit.

[0002]

[Description of the Prior Art] Input voltage is changed into high-frequency voltage by the switching means, it is impressed by the primary coil of a transformer, and the switching power supply equipment which took out the secondary coil of this transformer from the output circuit which has a rectifier circuit as a dc output is known well. In this switching power supply equipment, it connects with a rectifying device, magnetic cells, such as a coil, and secondary coils, such as diode connected to the secondary coil of a transformer at the serial, at juxtaposition, and a rectifier circuit is equipped with another rectifying device. On-off control of the switching means of an input side is carried out by the control signal from a control circuit so that output voltage may serve as a predetermined value. In the switching power supply equipment of this format, in order to mitigate loss by the forward drop voltage of a proper to diode, it replaces with diode and a switching device is used, the configuration which these switching devices are synchronized with the switching means of an input side, and was made to carry out on-off control is known as a synchronous detection mold switch power unit, and the typical thing of the switch power unit of such format is indicated by JP,4-4750,A, JP,5-260738,A and JP,7-194104,A, and the list at the U.S. Pat. No. 4,870,555 description.

[0003] An example of the conventional synchronous detection mold switch power unit is shown in drawing 5 . In drawing 5 , a power supply 13 is connected to primary-winding 11a of a transformer 11, and the switching device 1 of an FET mold is further connected to this primary-winding 11a. The output circuit 14 which has a rectifier circuit 12 is connected to secondary coil 11b of a transformer 11, and this output circuit 14 is connected to a load 15. A rectifier circuit 12 is equipped with 2nd switching device 2 and magnetic cell, i.e., inductor, 12a connected to secondary-winding 11b of a transformer 11 at the serial. Moreover, a rectifier circuit 12 is equipped with the 3rd switching device 3 connected to juxtaposition at secondary-winding 11b of a transformer 11. In order to control switching devices 1, 2, and 3, the control circuit 4 is formed. It connects with the output circuit 14 through the insulating circuit 9 or the load voltage detector 10 which consists of a photo coupler or a transformer, and a control circuit 4 outputs the control signal V4 for controlling a switching device 1 which modulated pulse width so that output voltage might become fixed. The output V4 of a control circuit 4 is impressed to the gate electrode of the 1st switching device 1 as an output V1 through the actuation circuit 5. The control signal V4 from a control circuit 4 is connected to the actuation circuits 6 and 7 again through the insulating circuit 9 which consisted of a transformer or a photo coupler. The actuation circuit 6 impresses the same polar output V2 as the output V1 impressed to the 1st switching device 1 to the gate electrode of the 2nd switching device 2. The actuation circuit 7

impresses the output V3 of reversed polarity to the gate electrode of the 3rd switching device 3 with the output V1 impressed to the 1st switching device 1.

[0004] As everyone knows, on-off control of the 1st switching device 1 is carried out by the control signal from a control circuit 4, voltage from a power supply 13 is made into high-frequency voltage, and this high-frequency voltage is impressed to the primary winding of a transformer 11. It is rectified by the rectifier circuit 12 and the voltage generated in secondary-winding 11b of a transformer 11 is outputted from an output circuit 14. The output voltage of an output circuit 14 is detected by the load voltage detector 10, and is inputted into a control circuit 4. A control circuit 4 generates the control signal for controlling the 1st switching device 1 so that output voltage serves as a predetermined value. In a rectifier circuit 12, when the 1st switching device 1 is an ON state, the 2nd switching device 2 will also be in an ON state, and the 3rd switching device 3 is turned off. If the 1st switching device 1 becomes off, the 2 switching devices 2 of ** will also become off, and the 3rd switching device 3 will be turned on.

[0005] Here, when a control signal is impressed to the same timing as the 1st, 2nd, and 3rd switching device 1, 2, and 3, a gap is produced to timing of operation between each switching device for the operational characteristic of FET which constitutes a switching device. That is, there is a time delay of operation after the voltage impressed to a time delay of operation and a gate electrode until the drain current which flows this switching device after driver voltage is impressed to the gate electrode of a switching device reaches a steady-state value is severed until drain current will not flow. The effectiveness of switching power supply equipment falls for this time delay. If this point is explained to details, since voltage of an input side is high, generally FET which constitutes the switching device 1 of an input side will have comparatively high pressure-proofing, and what has small current capacity will be used. Therefore, this switching device 1 has a comparatively short time delay after a time delay and driver voltage after driver voltage is impressed to a gate electrode until it will be in an ON state are removed until it will be in an OFF state. On the other hand, voltage of an output side is low and, generally, as for FET which constitutes the switching devices 2 and 3 of an output side, the thing with low pressure-proofing which has large current capacity is used. For this reason, in these switching devices 2 and 3, a time delay after a time delay and driver voltage after driver voltage is impressed to a gate electrode until it will be in an ON state are removed until it will be in an OFF state is comparatively long.

[0006] The voltage or the current wave form of each part of switching power supply equipment shown in drawing 5 is shown in drawing 6. Time of day t0 If a control signal V4 becomes a high from a low, the output V1 from the actuation circuit 5 and the output V2 from the actuation circuit 6 will become a high simultaneously. Moreover, the output V3 from the actuation circuit 7 becomes a low to the same timing. this time of day t0 from -- after the time delay according to the operational characteristic of a switching element, and time of day t1 A switching element 1 is turned on and current I1 flows to upstream coil 11a of a transformer 11. Simultaneously, it is current I2 to secondary coil 11b of a transformer 11. It generates. Current I3 which was flowing to the switching element 3 by the OFF state of a switching element 1 Time of day t1 It begins to decrease and is time of day t2. It becomes zero. On the property of an element, since the actuation time delay of a switching element 3 is longer than the time delay of a switching element 1, at this event, a switching element 3 is still in an ON state. Therefore, secondary-winding 11b of a transformer 11 will be in a short circuit condition through switching elements 2 and 3, and a big short-circuit current flows and it causes degradation and a noise. Moreover, since the actuation time delay is longer than a switching element 1, at this event, a switching

element 2 also has a switching element 2 in an OFF state. Therefore, since the short-circuit current which flows through this switching element 2 will pass not along the channel between the drain sources but along internal parasitism diode, loss becomes large. It sets to drawing 6 and is current I2. A slash shows the current which flows to parasitism diode inside.

[0007] Time of day t3 If a control signal V4 becomes a low from a high, the output V1 from the actuation circuit 5 and the output V2 from the actuation circuit 6 will become a low. The output V3 of an actuation circuit becomes a high from a low to the same timing. time of day t3 from -- after the time delay according to the operational characteristic of a switching element, and time of day t4 a switching element 1 -- off -- becoming -- current I1 and I2 decreasing -- beginning -- current I3 It begins to increase. Since a switching element 3 still is not an ON state at this time, to this switching element 3, current comes to flow through parasitism diode, and loss becomes large. To drawing 6 , it is current I3. A look shows the current which flows to parasitism diode inside.

[0008]

[Problem(s) to be Solved by the Invention] This invention makes it to offer the switching power supply equipment which can control the loss by difference of the actuation time delay of the switching element of a switching circuit and the switching element of a rectifier circuit, and generating of a noise the technical problem which should be solved in the synchronous detection mold switching telegraph-key equipment of the format mentioned above.

[0009]

[Means for Solving the Problem] Switching power supply equipment by this invention for solving the above-mentioned technical problem A switching circuit which has the 1st switching means which changes input voltage into high-frequency voltage, It has ***** by which a primary coil was connected to this switching circuit, and a secondary coil was connected to an output circuit. This output circuit The 2nd switching means and magnetic cell which were connected to a secondary coil of a transformer at a serial, It has a rectification means which becomes a secondary coil from the 3rd switching means connected to juxtaposition. A control means which forms a control signal given to this 1st switching means in order to carry out on-off control of the 1st switching means so that output voltage may serve as a predetermined value is established. On-off control of the 2nd switching means is carried out by signal from a control means which synchronized with a control signal given to the 1st switching means. A control signal with which the 3rd switching means is given to the 1st switching means is equipment of a synchronous detection mold by which on-off control came to be carried out by signal from a control means which has timing of reverse. A power unit of this invention has a signal timing adjustment means to make it timing as which a control signal is inputted into the 1st switching means rather than timing as which a control signal is inputted into the 2nd and 3rd switching means become late in order to compensate a difference of an actuation time delay based on a resisting pressure property between the 1st switching means and the 2nd and 3rd switching means, or a difference of current capacity as the feature. As for this signal timing adjustment means, it is most desirable to constitute as a delay means to delay timing of a control signal inputted into the 1st switching means. In this case, as for this delay means, it is desirable to enable it to set up independently a time delay over an ON signal to the 1st switching means and a time delay over an off signal. A load current detection means is established and it is made for a time delay over an ON signal to the 1st switching means to be changed in a still more desirable mode of this invention according to magnitude of the load current.

[0010] In switching power supply equipment of this invention as mentioned above with a signal

timing adjustment means In order to compensate a difference of an actuation time delay based on a difference of a resisting pressure property between the 1st switching means and the 2nd and 3rd switching means Since it adjusts so that timing as which a control signal is inputted into the 1st switching means rather than timing as which a control signal is inputted into the 2nd and 3rd switching means may become late On--off timing of the 1st, 2nd, and 3rd switching element can be synchronized thoroughly, current which flows to parasitism diode of a switching element can be decreased, loss can be reduced, and generating of a noise can be controlled.

[0011]

[Example] Hereafter, the example of this invention is explained about drawing. If drawing 1 is referred to first, the circuit of the example shown here is almost the same as that also of the conventional circuit shown in drawing 5 , and a configuration and an operation, and a corresponding portion will attach the same agreement and will omit detailed explanation. In the circuit of this example, a delay circuit 8 is arranged in the circuit from the control circuit 4 to the actuation circuit 5 of the 1st switching element 1. The insulating circuit 9 connected to the actuation circuits 6 and 7 of the 2nd and 3rd switching element 2 and 3 is connected to a control circuit 4 between a control circuit 4 and a delay circuit 8. Therefore, although the direct input of the control signal V4 from a control circuit 4 is carried out to the actuation circuits 6 and 7, it is inputted into the actuation circuit 5 through a delay circuit 8. The voltage or the current wave form of each part of a circuit shown in drawing 2 at drawing 1 is shown. Time of day t0 If a control signal V4 becomes a high from a low, the output V2 from the actuation circuit 6 will become a high, and the output V3 from the actuation circuit 7 will become a low to the same timing simultaneously. the actuation circuit 5 of the 1st switching element 1 -- a control signal V4 -- time amount deltaT1 only -- since it is behind and is inputted -- output V1 of the actuation circuit 5 Time of day t0 Time amount deltaT1 only -- overdue time of day t1 from a low -- yes, it comes to be alike a switching element 1 -- time of day t0 from -- after the time delay according to the operating characteristic of this switching element, and time of day t2 ON -- becoming -- current I1 Primary-winding 11a of a transformer 11 flowing -- simultaneous -- secondary-winding 11b of a transformer 11 Current I2 It generates. Current I3 which was flowing to the switching element 3 by the OFF state of a switching element 1 Time of day t2 It begins to decrease and is time of day t3. It becomes zero. Time of day t3 It is current I1 and I2 then. A steady-state value is reached. a switching element 3 -- time of day t0 from -- after the time delay according to the operational characteristic of this switching element, and time of day t3 It turns off. **T1 Time of day t3 It is determined that a switching device 3 turns off. Since the time amount which the direction when turning off the actuation time delay in a switching element turns on is generally long, a switching element 2 is time of day t2. It is turned on when early. [0012] It sets in this circuit and is time of day t3. Current I3 Since the 3rd switching element 3 also becomes off when becoming zero, it can prevent that a short-circuit current flows to secondary-winding 11b of a transformer 11. current I2 Time of day t2 which begins to flow by -- since the 2nd switching element 2 is turned on -- current I2 Flowing the channel between the drain sources of an element 2, to parasitism diode, current hardly flows. Thus, in this example of this invention, loss can be reduced and a noise can be decreased. Time of day t4 If a control signal V4 becomes a low from a high, the output V2 of the actuation circuit 6 will become a low. The output V3 of an actuation circuit also becomes a high from a low to the same timing. the output V1 of the actuation circuit 5 of the 1st switching element 1 -- time of day t4 from -- time amount deltaT2 only -- overdue time of day t5 yes -- since -- it becomes a low. this time of day t5 from -- after the time delay according to the operational characteristic of a switching element,

and time of day t_6 a switching element 1 -- off -- becoming -- current I_1 and I_2 decreasing -- beginning -- current I_3 It begins to increase. Time amount ΔT_2 Since it has determined that it corresponds to the difference of an actuation time delay in case an actuation time delay and the 3rd switching element 3 in case the 1st switching element 1 is turned off from an ON state are turned on from an OFF state, it is time of day t_6 . When a switching element 1 becomes off, the switching element 3 is already turned on and current hardly flows through parasitism diode to this switching element 3.

[0013] Generally, the actuation time delay in a switching element is longer than the time of the direction when turning off turning on. Therefore, the timing which the 2nd switching element 2 turns off in this example is time of day t_6 . Overdue time of day t_7 It becomes. therefore, current I_2 -- time of day t_7 up to -- the channel of a switching element 2 can be flowed and it does not flow to parasitism diode Time delay ΔT_1 of a delay circuit in case a control signal V_4 becomes a high from a low in an above-mentioned example Time delay ΔT_2 of a delay circuit in case a control signal V_4 becomes a low from a high Although selecting separately, respectively is desirable, even if it makes it the same value, the effect of a considerable degree can be attained. In addition, time delay ΔT_2 of a delay circuit in case a control signal V_4 becomes a low from a high depending on the configuration of a circuit, an input state, or the property of a switching element It is good also as zero.

[0014] Other examples of this invention are shown in drawing 3 . In this example, the control circuit 4 is arranged in the secondary circuit of a transformer 11, and the control signal V_4 from this control circuit 4 is directly inputted into the actuation circuits 6 and 7, without passing through an insulating circuit. In respect of others, this example is the same as the example of drawing 1 , and the same is said of the actuation. Drawing 4 shows still more nearly another example of this invention. In this example, the current detector 15 is established in the upstream circuit of a transformer 11. It connects with a delay circuit 8, it responds to reduction in the output current, and this current detector 15 is a time delay ΔT_1 . It becomes large, it responds to the increment in the output current, and is a time delay ΔT_1 . A delay circuit 8 is controlled to become small. When the load current decreases with the configuration of the example of drawing 1 , it is current I_3 . The time of day and current I_1 which become zero from a steady-state value, and I_2 The time of day which becomes a steady-state value from zero is t_3 . It becomes early and is time of day t_2 . It approaches. However, the time of day which the 3rd switching element 3 turns off is t_3 . Since it is as, while the switching element 3 is continuing the ON state, switching elements 1 and 2 are turned on. For this reason, in the circuit which passes along the secondary coil of a transformer 11, a short-circuit current flows through switching elements 2 and 3, and it becomes the cause of noise generating in it. Since the example of drawing 4 controls a time delay according to the output current, it can solve this problem.

[0015] The trial calculation of the improvement in efficiency which can be attained by the configuration of this invention was made about the specific example. As an assumption, in the conventional circuit, the current between 211 nS(s) flows to the parasitism diode of a switching element, and the voltage drop in parasitism diode is set to 0.9 V by the difference in the delay of a switching element of operation. The specification of a power unit sets $V_0 = 3.3$ V, $I_0 = 15$ A, and drive frequency to 250 kHz, and sets the resistance in the switch-on of a switching element to 5.7mohm. If effectiveness at the time of constituting a rectifier circuit from diode is made into 75%, it is FET about this diode. The effectiveness of synchronous detection mold switching power supply equipment equipped with the rectifier circuit replaced with the switching element of a mold becomes 82.9%, and the effectiveness of the equipment of the example of this

invention shown in drawing 1 becomes 83.9%. In this count, only an improvement of the effectiveness acquired by compensating the actuation delay of a switching element among the effects acquired by this invention is taken into consideration. The improvement effect of loss resulting from a short-circuit current is attained, and the noise relief effect is also remarkable in this invention.

[0016] Actuation time delay ΔT_2 in the circuit of the specification used for above-mentioned count at drawing 7 It considers as zero and is ΔT_1 . Change of the effectiveness at the time of making it change and change of a short-circuit current and recovery current are shown. Here, a short-circuit current and recovery current are current I3 which flows the 3rd switching element 3. The current which flows to an arrow head and an opposite direction is pointed out inside. When a time delay is made to increase from this drawing, it turns out that a short-circuit current decreases and effectiveness is improved about 5%. There is also a portion which compensation of the actuation delay of the 2nd switching element 2 contributes in this improvement in efficiency. When a time delay becomes large too much, it is current I3. Since the condition that the 3rd switching element 3 turns off is produced while flowing, it is current I3. Parasitism diode will be flowed and effectiveness falls. It is current I3 to parasitism diode. If the 1st switching element 1 is turned on while flowing, recovery current will flow to the parasitism diode of the 3rd switching element 3. This recovery current increases in proportion to a time delay, and becomes the cause which worsens effectiveness.

[0017] In addition, in the example of drawing 4 , although the current detector 15 linked to the primary side circuit of a transformer 11 was used for detection of the load current, this current detector 15 may be established in the secondary circuit of a transformer 11.

TECHNICAL FIELD

[Industrial Application] This invention switches input voltage by the switching means, changes it into high-frequency voltage, and relates to the switching power supply equipment which transforms this high-frequency voltage with a transformer, rectifies and outputs the output voltage of arbitration. Especially this invention establishes a switching means as a rectifying device of the rectifier circuit of the output section, and relates to the synchronous detection mold switching power supply equipment it was made to operate this switching means synchronizing with actuation of the switching means of an input circuit.

PRIOR ART

[Description of the Prior Art] Input voltage is changed into high-frequency voltage by the switching means, it is impressed by the primary coil of a transformer, and the switching power supply equipment which took out the secondary coil of this transformer from the output circuit which has a rectifier circuit as a dc output is known well. In this switching power supply equipment, it connects with a rectifying device, magnetic cells, such as a coil, and secondary coils, such as diode connected to the secondary coil of a transformer at the serial, at juxtaposition, and a rectifier circuit is equipped with another rectifying device. On-off control of the switching means of an input side is carried out by the control signal from a control circuit so that output voltage may serve as a predetermined value. In the switching power supply equipment of this format, in order to mitigate loss by the forward drop voltage of a proper to diode, it replaces with diode and a switching device is used, the configuration which these switching devices are synchronized with the switching means of an input side, and was made to carry out on-off control is known as a synchronous detection mold switch power unit, and the typical thing of the switch power unit of such format is indicated by JP,4-4750,A, JP,5-260738,A and JP,7-194104,A, and the list at the U.S. Pat. No. 4,870,555 description.

[0003] An example of the conventional synchronous detection mold switch power unit is shown in drawing 5. In drawing 5, a power supply 13 is connected to primary-winding 11a of a transformer 11, and the switching device 1 of an FET mold is further connected to this primary-winding 11a. The output circuit 14 which has a rectifier circuit 12 is connected to secondary coil 11b of a transformer 11, and this output circuit 14 is connected to a load 15. A rectifier circuit 12 is equipped with 2nd switching device 2 and magnetic cell, i.e., inductor, 12a connected to secondary-winding 11b of a transformer 11 at the serial. Moreover, a rectifier circuit 12 is equipped with the 3rd switching device 3 connected to juxtaposition at secondary-winding 11b of a transformer 11. In order to control switching devices 1, 2, and 3, the control circuit 4 is formed. It connects with the output circuit 14 through the insulating circuit 9 or the load voltage detector 10 which consists of a photo coupler or a transformer, and a control circuit 4 outputs the control signal V4 for controlling a switching device 1 which modulated pulse width so that output voltage might become fixed. The output V4 of a control circuit 4 is impressed to the gate electrode of the 1st switching device 1 as an output V1 through the actuation circuit 5. The control signal V4 from a control circuit 4 is connected to the actuation circuits 6 and 7 again through the insulating circuit 9 which consisted of a transformer or a photo coupler. The actuation circuit 6 impresses the same polar output V2 as the output V1 impressed to the 1st switching device 1 to the gate electrode of the 2nd switching device 2. The actuation circuit 7 impresses the output V3 of reversed polarity to the gate electrode of the 3rd switching device 3 with the output V1 impressed to the 1st switching device 1.

[0004] As everyone knows, on-off control of the 1st switching device 1 is carried out by the control signal from a control circuit 4, voltage from a power supply 13 is made into high-frequency voltage, and this high-frequency voltage is impressed to the primary winding of a transformer 11. It is rectified by the rectifier circuit 12 and the voltage generated in secondary-winding 11b of a transformer 11 is outputted from an output circuit 14. The output voltage of an output circuit 14 is detected by the load voltage detector 10, and is inputted into a control circuit 4. A control circuit 4 generates the control signal for controlling the 1st switching device 1 so that output voltage serves as a predetermined value. In a rectifier circuit 12, when the 1st

switching device 1 is an ON state, the 2nd switching device 2 will also be in an ON state, and the 3rd switching device 3 is turned off. If the 1st switching device 1 becomes off, the 2 switching devices 2 of ** will also become off, and the 3rd switching device 3 will be turned on.

[0005] Here, when a control signal is impressed to the same timing as the 1st, 2nd, and 3rd switching device 1, 2, and 3, a gap is produced to timing of operation between each switching device for the operational characteristic of FET which constitutes a switching device. That is, there is a time delay of operation after the voltage impressed to a time delay of operation and a gate electrode until the drain current which flows this switching device after driver voltage is impressed to the gate electrode of a switching device reaches a steady-state value is severed until drain current will not flow. The effectiveness of switching power supply equipment falls for this time delay. If this point is explained to details, since voltage of an input side is high, generally FET which constitutes the switching device 1 of an input side will have comparatively high pressure-proofing, and what has small current capacity will be used. Therefore, this switching device 1 has a comparatively short time delay after a time delay and driver voltage after driver voltage is impressed to a gate electrode until it will be in an ON state are removed until it will be in an OFF state. On the other hand, voltage of an output side is low and, generally, as for FET which constitutes the switching devices 2 and 3 of an output side, the thing with low pressure-proofing which has large current capacity is used. For this reason, in these switching devices 2 and 3, a time delay after a time delay and driver voltage after driver voltage is impressed to a gate electrode until it will be in an ON state are removed until it will be in an OFF state is comparatively long.

[0006] The voltage or the current wave form of each part of switching power supply equipment shown in drawing 5 is shown in drawing 6. Time of day t_0 If a control signal V_4 becomes a high from a low, the output V_1 from the actuation circuit 5 and the output V_2 from the actuation circuit 6 will become a high simultaneously. Moreover, the output V_3 from the actuation circuit 7 becomes a low to the same timing. this time of day t_0 from -- after the time delay according to the operational characteristic of a switching element, and time of day t_1 A switching element 1 is turned on and current I_1 flows to upstream coil 11a of a transformer 11. Simultaneously, it is current I_2 to secondary coil 11b of a transformer 11. It generates. Current I_3 which was flowing to the switching element 3 by the OFF state of a switching element 1 Time of day t_1 It begins to decrease and is time of day t_2 . It becomes zero. On the property of an element, since the actuation time delay of a switching element 3 is longer than the time delay of a switching element 1, at this event, a switching element 3 is still in an ON state. Therefore, secondary-winding 11b of a transformer 11 will be in a short circuit condition through switching elements 2 and 3, and a big short-circuit current flows and it causes degradation and a noise. Moreover, since the actuation time delay is longer than a switching element 1, at this event, a switching element 2 also has a switching element 2 in an OFF state. Therefore, since the short-circuit current which flows through this switching element 2 will pass not along the channel between the drain sources but along internal parasitism diode, loss becomes large. It sets to drawing 6 and is current I_2 . A slash shows the current which flows to parasitism diode inside.

[0007] Time of day t_3 If a control signal V_4 becomes a low from a high, the output V_1 from the actuation circuit 5 and the output V_2 from the actuation circuit 6 will become a low. The output V_3 of an actuation circuit becomes a high from a low to the same timing. time of day t_3 from -- after the time delay according to the operational characteristic of a switching element, and time of day t_4 a switching element 1 -- off -- becoming -- current I_1 and I_2 decreasing -- beginning -- current I_3 It begins to increase. Since a switching element 3 still is not an ON state at this time,

to this switching element 3, current comes to flow through parasitism diode, and loss becomes large. To drawing 6 , it is current I_3 . A look shows the current which flows to parasitism diode inside.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] This invention makes it to offer the switching power supply equipment which can control the loss by difference of the actuation time delay of the switching element of a switching circuit and the switching element of a rectifier circuit, and generating of a noise the technical problem which should be solved in the synchronous detection mold switching telegraph-key equipment of the format mentioned above.

MEANS

[Means for Solving the Problem] Switching power supply equipment by this invention for solving the above-mentioned technical problem A switching circuit which has the 1st switching means which changes input voltage into high-frequency voltage, It has ***** by which a primary coil was connected to this switching circuit, and a secondary coil was connected to an output circuit. This output circuit The 2nd switching means and magnetic cell which were connected to a secondary coil of a transformer at a serial, It has a rectification means which becomes a secondary coil from the 3rd switching means connected to juxtaposition. A control means which forms a control signal given to this 1st switching means in order to carry out on-off control of the 1st switching means so that output voltage may serve as a predetermined value is established. On-off control of the 2nd switching means is carried out by signal from a control means which synchronized with a control signal given to the 1st switching means. A control signal with which the 3rd switching means is given to the 1st switching means is equipment of a synchronous detection mold by which on-off control came to be carried out by signal from a control means which has timing of reverse. A power unit of this invention has a signal timing adjustment means to make it timing as which a control signal is inputted into the 1st switching means rather than timing as which a control signal is inputted into the 2nd and 3rd switching means become late in order to compensate a difference of an actuation time delay based on a resisting pressure property between the 1st switching means and the 2nd and 3rd switching means, or a difference of current capacity as the feature. As for this signal timing adjustment means, it is most desirable to constitute as a delay means to delay timing of a control signal inputted into the 1st switching means. In this case, as for this delay means, it is desirable to enable it to set up independently a time delay over an ON signal to the 1st switching means and a time delay over an off signal. A load current detection means is established and it is made for a time delay over an ON signal to the 1st switching means to be changed in a still more desirable mode of this invention according to magnitude of the load current.

[0010] In switching power supply equipment of this invention as mentioned above with a signal timing adjustment means In order to compensate a difference of an actuation time delay based on a difference of a resisting pressure property between the 1st switching means and the 2nd and 3rd switching means Since it adjusts so that timing as which a control signal is inputted into the 1st switching means rather than timing as which a control signal is inputted into the 2nd and 3rd switching means may become late On--off timing of the 1st, 2nd, and 3rd switching element can be synchronized thoroughly, current which flows to parasitism diode of a switching element can be decreased, loss can be reduced, and generating of a noise can be controlled.

EXAMPLE

[Example] Hereafter, the example of this invention is explained about drawing. If drawing 1 is referred to first, the circuit of the example shown here is almost the same as that also of the conventional circuit shown in drawing 5, and a configuration and an operation, and a corresponding portion will attach the same agreement and will omit detailed explanation. In the circuit of this example, a delay circuit 8 is arranged in the circuit from the control circuit 4 to the actuation circuit 5 of the 1st switching element 1. The insulating circuit 9 connected to the actuation circuits 6 and 7 of the 2nd and 3rd switching element 2 and 3 is connected to a control circuit 4 between a control circuit 4 and a delay circuit 8. Therefore, although the direct input of the control signal V4 from a control circuit 4 is carried out to the actuation circuits 6 and 7, it is inputted into the actuation circuit 5 through a delay circuit 8. The voltage or the current wave form of each part of a circuit shown in drawing 2 at drawing 1 is shown. Time of day t0 If a control signal V4 becomes a high from a low, the output V2 from the actuation circuit 6 will become a high, and the output V3 from the actuation circuit 7 will become a low to the same timing simultaneously. the actuation circuit 5 of the 1st switching element 1 -- a control signal V4 -- time amount deltaT1 only -- since it is behind and is inputted -- output V1 of the actuation circuit 5 Time of day t0 Time amount deltaT1 only -- overdue time of day t1 from a low -- yes, it comes to be alike a switching element 1 -- time of day t0 from -- after the time delay according to the operating characteristic of this switching element, and time of day t2 ON -- becoming -- current I1 Primary-winding 11a of a transformer 11 flowing -- simultaneous -- secondary-winding 11b of a transformer 11 Current I2 It generates. Current I3 which was flowing to the switching element 3 by the OFF state of a switching element 1 Time of day t2 It begins to decrease and is time of day t3. It becomes zero. Time of day t3 It is current I1 and I2 then. A steady-state value is reached. a switching element 3 -- time of day to from -- after the time delay according to the operational characteristic of this switching element, and time of day t3 It turns off. **T1 Time of day t3 It is determined that a switching device 3 turns off. Since the time amount which the direction when turning off the actuation time delay in a switching element turns on is generally long, a switching element 2 is time of day t2. It is turned on when early. [0012] It sets in this circuit and is time of day t3. Current I3 Since the 3rd switching element 3 also becomes off when becoming zero, it can prevent that a short-circuit current flows to secondary-winding 11b of a transformer 11. current I2 Time of day t2 which begins to flow by -- since the 2nd switching element 2 is turned on -- current I2 Flowing the channel between the drain sources of an element 2, to parasitism diode, current hardly flows. Thus, in this example of this invention, loss can be reduced and a noise can be decreased. Time of day t4 If a control signal V4 becomes a low from a high, the output V2 of the actuation circuit 6 will become a low. The output V3 of an actuation circuit also becomes a high from a low to the same timing. the output V1 of the actuation circuit 5 of the 1st switching element 1 -- time of day t4 from -- time amount deltaT2 only -- overdue time of day t5 yes -- since -- it becomes a low. this time of day t5 from -- after the time delay according to the operational characteristic of a switching element, and time of day t6 a switching element 1 -- off -- becoming -- current I1 and I2 decreasing -- beginning -- current I3 It begins to increase. Time amount deltaT2 Since it has determined that it corresponds to the difference of an actuation time delay in case an actuation time delay and the 3rd switching element 3 in case the 1st switching element 1 is turned off from an ON state are turned on from an OFF state, it is time of day t6. When a switching element 1 becomes off, the

switching element 3 is already turned on and current hardly flows through parasitism diode to this switching element 3.

[0013] Generally, the actuation time delay in a switching element is longer than the time of the direction when turning off turning on. Therefore, the timing which the 2nd switching element 2 turns off in this example is time of day t_6 . Overdue time of day t_7 It becomes. therefore, current I2 -- time of day t_7 up to -- the channel of a switching element 2 can be flowed and it does not flow to parasitism diode Time delay ΔT_1 of a delay circuit in case a control signal V4 becomes a high from a low in an above-mentioned example Time delay ΔT_2 of a delay circuit in case a control signal V4 becomes a low from a high Although selecting separately, respectively is desirable, even if it makes it the same value, the effect of a considerable degree can be attained. In addition, time delay ΔT_2 of a delay circuit in case a control signal V4 becomes a low from a high depending on the configuration of a circuit, an input state, or the property of a switching element It is good also as zero.

[0014] Other examples of this invention are shown in drawing 3 . In this example, the control circuit 4 is arranged in the secondary circuit of a transformer 11, and the control signal V4 from this control circuit 4 is directly inputted into the actuation circuits 6 and 7, without passing through an insulating circuit. In respect of others, this example is the same as the example of drawing 1 , and the same is said of the actuation. Drawing 4 shows still more nearly another example of this invention. In this example, the current detector 15 is established in the upstream circuit of a transformer 11. It connects with a delay circuit 8, it responds to reduction in the output current, and this current detector 15 is a time delay ΔT_1 . It becomes large, it responds to the increment in the output current, and is a time delay ΔT_1 . A delay circuit 8 is controlled to become small. When the load current decreases with the configuration of the example of drawing 1 , it is current I3. The time of day and current I1 which become zero from a steady-state value, and I2 The time of day which becomes a steady-state value from zero is t_3 . It becomes early and is time of day t_2 . It approaches. However, the time of day which the 3rd switching element 3 turns off is t_3 . Since it is as, while the switching element 3 is continuing the ON state, switching elements 1 and 2 are turned on. For this reason, in the circuit which passes along the secondary coil of a transformer 11, a short-circuit current flows through switching elements 2 and 3, and it becomes the cause of noise generating in it. Since the example of drawing 4 controls a time delay according to the output current, it can solve this problem.

[0015] The trial calculation of the improvement in efficiency which can be attained by the configuration of this invention was made about the specific example. As an assumption, in the conventional circuit, the current between 211 nS(s) flows to the parasitism diode of a switching element, and the voltage drop in parasitism diode is set to 0.9 V by the difference in the delay of a switching element of operation. The specification of a power unit sets $V_0 = 3.3$ V, $I_0 = 15$ A, and drive frequency to 250 kHz, and sets the resistance in the switch-on of a switching element to 5.7mohm. If effectiveness at the time of constituting a rectifier circuit from diode is made into 75%, it is FET about this diode. The effectiveness of synchronous detection mold switching power supply equipment equipped with the rectifier circuit replaced with the switching element of a mold becomes 82.9%, and the effectiveness of the equipment of the example of this invention shown in drawing 1 becomes 83.9%. In this count, only an improvement of the effectiveness acquired by compensating the actuation delay of a switching element among the effects acquired by this invention is taken into consideration. The improvement effect of loss resulting from a short-circuit current is attained, and the noise relief effect is also remarkable in this invention.

[0016] Actuation time delay ΔT_2 in the circuit of the specification used for above-mentioned count at drawing 7 It considers as zero and is ΔT_1 . Change of the effectiveness at the time of making it change and change of a short-circuit current and recovery current are shown. Here, a short-circuit current and recovery current are current I_3 which flows the 3rd switching element 3. The current which flows to an arrow head and an opposite direction is pointed out inside. When a time delay is made to increase from this drawing, it turns out that a short-circuit current decreases and effectiveness is improved about 5%. There is also a portion which compensation of the actuation delay of the 2nd switching element 2 contributes in this improvement in efficiency. When a time delay becomes large too much, it is current I_3 . Since the condition that the 3rd switching element 3 turns off is produced while flowing, it is current I_3 . Parasitism diode will be flowed and effectiveness falls. It is current I_3 to parasitism diode. If the 1st switching element 1 is turned on while flowing, recovery current will flow to the parasitism diode of the 3rd switching element 3. This recovery current increases in proportion to a time delay, and becomes the cause which worsens effectiveness.

[0017] In addition, in the example of drawing 4 , although the current detector 15 linked to the primary side circuit of a transformer 11 was used for detection of the load current, this current detector 15 may be established in the secondary circuit of a transformer 11.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the circuit diagram showing the switching power supply equipment by one example of this invention.

[Drawing 2] It is the wave form chart showing the voltage of each part in the circuit of drawing 1 , or the wave of current.

[Drawing 3] It is the same circuit diagram as drawing 1 which shows the switching power supply equipment by other examples of this invention.

[Drawing 4] It is the same circuit diagram as drawing 1 which shows the switching power supply equipment by the example of further others of this invention.

[Drawing 5] It is the same circuit diagram as drawing 1 which shows an example of conventional synchronous detection mold switching power supply equipment.

[Drawing 6] It is drawing showing the wave of each part in the circuit of drawing 5 .

[Drawing 7] It is the chart showing change of an improvement of the effectiveness acquired by this invention by the time delay in an example, a short-circuit current, and recovery current.

[Explanation of agreement]

1, 2, 3 [... A delay circuit, 9 / ... An insulating circuit 10 / ... A load voltage detector, 11 / ... A transformer, 12 / ... A rectifier circuit, 13 / ... A power supply, 14 / ... An output circuit, 15 / ... Load] ... A switching element, 4 ... A control circuit, 5, 6, 7 ... An actuation circuit, 8

CORRECTION OR AMENDMENT

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[Procedure amendment]

[Filing Date] November 16, Heisei 11 (1999. 11.16)

[Procedure amendment 1]

[Document to be Amended] Description

[Item(s) to be Amended] Claim

[Method of Amendment] Modification

[Proposed Amendment]

[Claim(s)]

[Claim 1] A switching circuit which has the 1st switching means which changes input voltage into high-frequency voltage,

***** by which a primary coil was connected to said switching circuit, and a secondary coil was connected to an output circuit,

A preparation and said output circuit have a rectification means which becomes the 2nd switching means and a magnetic cell which were connected to said secondary coil of said transformer at a serial, and said secondary coil from the 3rd switching means connected to juxtaposition,

In order to carry out on-off control of said 1st switching means so that output voltage may serve as a predetermined value, a control means which forms a control signal given to said 1st switching means is established,

On-off control of said 2nd switching means is carried out by signal from said control means which synchronized with a control signal given to said 1st switching means,

A control signal with which said 3rd switching means is given to said 1st switching means is a synchronous detection mold power unit by which on-off control came to be carried out by signal

from said control means which has timing of reverse,

Synchronous detection mold switching power supply equipment characterized by what a signal timing adjustment means to make it timing as which a control signal is inputted into said 1st switching means rather than timing as which a control signal is inputted into said 2nd and 3rd switching means in order to compensate a difference of an actuation time delay based on said 1st switching means, said 2nd [the] and a resisting pressure property between said 3rd switching means, or a difference of current capacity become late was established for.

[Claim 2] It is switching power supply equipment characterized by being a delay means to delay the timing of a control signal of being switching power supply equipment indicated to claim 1, and inputting said signal timing adjustment means into said 1st switching means.

[Claim 3] It is switching power supply equipment characterized by the ability to set up now independently a time delay [as opposed to / are switching power supply equipment indicated to claim 2, and / an ON signal to said 1st switching means in said delay means], and a time delay over an off signal.

[Claim 4] Switching power supply equipment characterized by being switching power supply equipment indicated to claim 3, establishing a load current detection means, and coming to change a time delay over an ON signal to said 1st switching means according to magnitude of the load current.